PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

EVERY, David, Aidan
Marks & Clerk
Sussex House
83-85 Mosley Street
Manchester M2 3LG
ROYAUME-UNI

Date of mailing (day/month/year)
25 September 2000 (25.09.00)

Applicant's or agent's file reference
DE/J088190PWO

IMPORTANT NOTIFICATION

International application No.
PCT/GB99/02141

International filing date (day/month/year)
05 July 1999 (05.07.99)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
MARSH, Peter, Gordon
33 Hopwood Avenue
Hopwood
Heywood OL10 2AX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
DE LA MARCHE, Peter William
33 Hopwood Avenue
Hopwood
Heywood OL10 2AX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
Jean-Marie McAdams

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 16 March 2000 (16.03.00)	
International application No. PCT/GB99/02141	**Applicant's or agent's file reference** DE/J088190PWO
International filing date (day/month/year) 05 July 1999 (05.07.99)	**Priority date** (day/month/year) 03 July 1998 (03.07.98)
Applicant MARSH, Peter, Gordon	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

02 February 2000 (02.02.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Pascal Piriou
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : E04B 1/348 — A1

(11) International Publication Number: WO 00/01898

(43) International Publication Date: 13 January 2000 (13.01.00)

(21) International Application Number: PCT/GB99/02141

(22) International Filing Date: 5 July 1999 (05.07.99)

(30) Priority Data:
9814332.4 3 July 1998 (03.07.98) GB

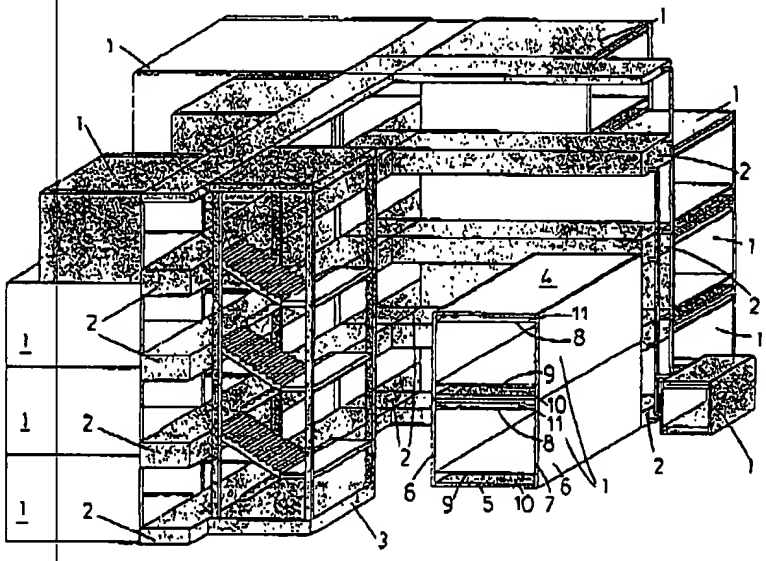
(71)(72) Applicant and Inventor: MARSH, Peter, Gordon [GB/GB]; 33 Hopwood Avenue, Hopwood, Heywood OL10 2AX (GB).

(74) Agent: EVERY, David, Aidan; Marks & Clerk, Sussex House, 83–85 Mosley Street, Manchester M2 3LG (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: MODULAR BUILDINGS



(57) Abstract

A modular building structure comprises a service corridor (2) to which are connected separate cabin modules (1) that form accommodation or offices etc. The service module contains apparatus for the supply and distribution of mains services such as water, electricity, waste disposal and air conditioning to the building modules. The modules are connected to the corridor and to said mains supply services. Each of the cabin modules is free-standing, pre-fitted for its intended use. Adjacent modules are interconnected by a flexible grommet (26) that extends between aligned apertures in each module.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/02141

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B1/348

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 32 26 742 A (DIETRICH RICHARD DIPL ING) 19 January 1984 (1984-01-19)	1,2,5,23
A	page 9, line 16 -page 13, line 23; figures 1,2	7,10,13, 15,24
X	US 3 742 666 A (ANTONIOU A) 3 July 1973 (1973-07-03) the whole document	1,15
A	GB 1 493 802 A (PORTAKABIN LTD) 30 November 1977 (1977-11-30) the whole document	1,12,17, 21,25
A	DE 32 29 881 A (INTERATOM) 16 February 1984 (1984-02-16) the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1999	22/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax (+31–70) 340–3016	Vrugt, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

ormation on patent family members

Inform nal Application No
PCT/GB 99/02141

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 3226742	A	19-01-1984	NONE		
US 3742666	A	03-07-1973	AU	4541672 A	14-02-1974
			CA	955186 A	24-09-1974
			DE	2242274 A	22-03-1973
			FR	2152156 A	20-04-1973
			IT	986030 B	10-01-1975
			JP	48036927 A	31-05-1973
GB 1493802	A	30-11-1977	NONE		
DE 3229881	A	16-02-1984	NONE		

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

EVERY, David, Aidan
Marks & Clerk
Sussex House
83-85 Mosley Street
Manchester M2 3LG
ROYAUME-UNI

- 6 OCT 2000

Date of mailing (day/month/year)
26 September 2000 (26.09.00)

Applicant's or agent's file reference
DE/J088190PWO

International application No.
PCT/GB99/02141

IMPORTANT NOTIFICATION

International filing date (day/month/year)
05 July 1999 (05.07.99)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
MARSH, Peter, Gordon
33 Hopwood Avenue
Hopwood
Heywood OL10 2AX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
DE LA MARCHE, Peter William
33 Hopwood Avenue
Hopwood
Heywood OL10 2AX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
Jean-Marie McAdams

Telephone No.: (41-22) 338.83.38

Form PCT/IB/306 (March 1994)

003544382

88711

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To.

EVERY, D
MARKS & CLERK
Sussex House
83-85 Mosley Street
MANCHESTER M2 3LG
GRANDE BRETAGNE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	12.10.2000
Applicant's or agent's file reference DE/J088190PWO	IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/02141	05/07/1999	03/07/1998

Applicant
MARSH, Peter. Gordon

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx. 523656 epmu d Fax: +49 89 2399 - 4465	Beuschel, H Tel.+49 89 2399-2971

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
DE/J088190PWO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/02141	05/07/1999	03/07/1998
International Patent Classification (IPC) or national classification and IPC		
E04B1/348		
Applicant		
MARSH, Peter. Gordon		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/02/2000	12.10.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Rosborough, J Telephone No. +49 89 2399 2618

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/02141

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

4-14	as originally filed			
1-3	as received on	18/07/2000	with letter of	13/07/2000

Claims, No.:

1-21	as received on	18/07/2000	with letter of	13/07/2000

Drawings, sheets:

1/9-9/9	as originally filed

2. The amendments have resulted in the cancellation of:

☐	the description,	pages:
☒	the claims,	Nos.: 22-25
☐	the drawings,	sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

see separate sheet

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/02141

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose. according to Rule 68.1. not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-21
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/02141

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/GB99/02141

Re Item IV

Lack of unity of invention

Unity of invention (Rule 13.1 PCT) does not exist between the subject-matter of the following groups of independent claims because a technical relationship involving one or more of the same or corresponding special technical features in the sense of Rule 13.2 PCT is not present.

The separate inventions and their respective special technical feature(s) are as follows:

Invention A): Claims 1 and 14 — Special technical features - the service module defining a plurality of connection nodes and being in the form of / furnished such that it is in the form of a corridor walkway linking the building modules.

Invention B): Claim 16 — Apparatus for connecting building modules
Special technical features - a flexible resilient insert inserted in an aperture in one building module, said insert being attached to an adjacent module and supported on a fixing element that is secured to said adjacent building module.

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US-A-3,742,666
D2: DE-A-32 26 742
D3: GB-A-1 498 802.

5.1 Independent Claim 1.

Document D1, which is considered to represent the most relevant state of the art, discloses:
- a modular building structure comprising a service module (fig.1, (17)) defining a plurality of connection nodes (fig.5, (124-127, 134) or fig.1 (133,150)) for connection to separate building modules (fig.1, (18-20),
- the service module containing apparatus for the supply and distribution of at least one mains service to the building modules,
- each building module being free-standing, pre-fitted for its intended use (column 3, lines 5-10, and fig.11) and connected to one of said connection nodes and to said supply of at least one mains service.

from which the subject-matter of claim 1 differs in that:
- the service module is in the form of a corridor walkway linking the building modules.

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT).

The problem to be solved by the present invention may therefore be regarded as:
to provide a corridor for the building structure of D1.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT), as D1 teaches the construction of the service module to be as compact as possible (column 1, lines 58-62 and figs.), and provides no indication to extend said module so that it provides a corridor walkway linking the building modules.

Document D2 discloses (cf. fig.1 and figs. 4 and 5, (61)) a service module in the form of a room, particularly a bathroom. It provides no indication to provide said service module in the form of a corridor walkway.
Moreover D2 does not disclose either separate building modules or connection nodes for the connection of the service module to said building modules.

5.2 Independent Claim 14.

Independent claim 14 is directed to a method for constructing a modular building structure. For the reasons provides under item 5.1, the subject-matter of claim 14 also conforms to the requirements of Articles 33(2) and (3) PCT.

5.3 Independent Claim 16.

Document D3, which is considered to represent the most relevant state of the art, discloses an apparatus for connecting adjacent building modules.
Neither D3, nor any of the remaining available prior art documents either discloses or provides an indication for the remaining features of claim 16.
The subject-matter of claim 1 therefore conforms to the requirements of Articles 33(2) and (3) PCT.

5.4 Dependent Claims 2-13; 15; and 17-21.

Claims 2-13; 15; and 17-21 are dependent on claims 1; 14; and 16 respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VII
Certain defects in the international application

7.1 Two-Part Form.
The claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document D1) being placed in a preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in a characterising part (Rule 6.3(b)(ii) PCT).

7.2 Reference Signs.
The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

Certain observations on the international application

8.1 Description.

According to the requirements of Rule 11.13(l) reference signs not appearing in the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference signs (26) and (27), referred to on page 6, line 14 and the reference to a "collar" on page 7, lines 9 and 10.

1

MODULAR BUILDINGS

The present invention relates to modular buildings and more particularly to their structure, the method of their construction and interconnection.

It is well known to provide for portable modular building in circumstances where accommodation is needed in an emergency or on a temporary basis. Such buildings have to be rapidly and easily assembled to meet demand for emergency habitable structures in times, for example, of natural or other disasters. In addition such buildings are often required in remote locations by workers employed in the construction industry where temporary accommodation is needed during the term of the construction project.

There is a need for an all-purpose modular building system that can be exploited by both the residential and commercial construction sectors of industry. To date, portable and prefabricated buildings designs have not proved suitable for application in both sectors. Modular buildings have the advantages that they are easy and quick to erect, dismantle or relocate, are readily transportable, and flexible in that they are reconfigurable to meet changing requirements in size or needs. Unfortunately existing designs of such buildings are generally of a temporary nature and are not suited to long-term or permanent applications.

Existing modular buildings suffer from several disadvantages including: racking which causes wear and tear to the structure of the building and often leads to leaks, creaks and structural damage; condensation; inadequate interior temperature control; ineffective noise insulation; and an excessive ingress of dirt and dust (particularly in environments such as construction sites).

US-A-3742666 describes a modular building construction in which a pre-fabricated module for utility supply systems such modules can be delivered in a pre-fitted state to the construction site and assembled with limited effort and time. The module has side wall openings by which it may be attached to building modules.

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages and to provide for a modular building construction that has improved life expectancy so that it meets the requirements of more permanent structures whilst

maintaining the benefits of its modular nature. The term "building module" is used hereinafter to refer to an inhabitable building block that can be used as living quarters, an office, a conference room, a lavatory or washroom or another room that forms part of a larger building structure.

According to a first aspect of the present invention there is provided a modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.

The modular structure of the present invention provides for a very flexible arrangement in that once the service module has been installed on site the building modules can then be connected thereto in the desired number and fashion. If there is a demand for more building modules these can be simply added without the need to lay further mains service supplies. Similarly, removal of a particular building module is also a simple operation. As the mains service supply is contained within the service module the need for preliminary ground excavation is eliminated. Moreover little or no foundations are required.

The corridor may conveniently be provided with floor and ceiling cavities in which the mains service supplies are routed. Preferably one building module is a dedicated plant room that feeds the mains supply service to the service module.

The service module is preferably sectional so that it can be extended or shortened to provide more or less connection nodes as required. More than one service module may be provided and they may extend in transverse directions. The mains service may be electricity, waste disposal, air conditioning, water etc. In the case of waste disposal, each service module is provided with a holding tank and is connected to a lavatory or wash area of an adjacent building module. Preferably the holding tanks of adjacent sections of a service module are connected by a suction waste pipe.

The arrangement eliminates the need for gravity operated waste disposal. In the case of air conditioning each service module is preferably fitted with a heat exchanger and has an external pump for evacuation of warm air. Each building module also has its own heat exchanger that is connected to the pump and heat exchanger of the adjacent service module.

Preferably each adjoining pair of building modules or service modules have apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

According to a second aspect of the present invention there is provided a method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

According to a third aspect of the present invention there is provided an apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being that is received in the aperture and supported on a fixing element that is secured to said adjacent building module.

The housing preferably further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

Preferably the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

Specific embodiments of the present inventions will now be described, by way of example only, with reference to the accompanying drawings in which:

CLAIMS

1. A modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.

2. A modular building structure according to claim 1, wherein each module is an open-ended box configuration.

3. A modular building structure according to claims 1 or 2, wherein the service module has floor and ceiling cavities in which the mains service supplies are routed.

4. A modular building structure according to any one of claims 1 to 3, wherein one building module is a dedicated plant room that feeds the mains supply service to the service module.

5. A modular building structure according to any preceding claim, wherein the service module is sectional so that it can be extended or shortened to provide more or less connection nodes as required.

6. A modular building structure according to any preceding claim wherein there is provided a plurality of service modules, some modules being disposed in a direction transverse to others.

7. A modular building structure according to claim 6, wherein the mains service is for waste disposal and each service module is provided with a holding tank that is connected to a lavatory or wash area of an adjacent building module.

8. A modular building structure according to claim 7, wherein holding tanks of adjacent service modules are connected by a suction waste pipe.

9. A modular building structure according to any preceding claim, wherein the mains service supply is air conditioning and each service module is fitted with a heat exchanger and has an external pump for evacuation of warm air.

10. A modular building structure according to claim 9, wherein each building module also has its own heat exchanger that is connected to the pump and heat exchanger of an adjacent service module.

11. A modular building structure according to any preceding claim, wherein each adjoining pair of building modules or service modules has apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is snugly received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

12. A modular building structure according to any preceding claim, comprising multiple storeys, vertically adjacent modules being connected by a connecting member comprising a resilient flexible insert attached to one module and received in an aperture of the vertically adjacent module.

13. A modular building structure according to any preceding claim, wherein the modules are connected to a foundation of foamed mineral in-fill.

14. A method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

15. A method according to claim 14, comprising further steps of filling a clearance between the module and ground with a foundation of foamed mineral in-fill.

16. Apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being received in the aperture and supported on a fixing element that is secured to said adjacent building module.

17. Apparatus according to claim 16, wherein each horizontally adjacent module has an aperture, the flexible resilient insert is received in each aperture and bridges the two building modules.

18. Apparatus according to claim 16, wherein the modules are vertically adjacent, one of the modules having projecting therefrom said resilient flexible insert and the other having said aperture.

19. Apparatus according to claims 17 or 18, wherein the housing further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

20. Apparatus according to claim any one of claims 16 to 19, wherein the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

21. Apparatus according to any one of claims 16 to 20, wherein the insert is a grommet.

Figure 1 is a perspective view of a modular building structure of the present invention constructed from a plurality of interconnected modules with certain panels removed for clarity;

Figure 2 is a sectioned side view of the intersection of two modules showing connecting points and a fixing assembly;

Figure 3 is a side view of a grommet of the fixing assembly shown in figure 2;

Figure 4 is a side view of a grommet housing of the connecting point shown in figure 2;

Figure 4a is a diagrammatic representation of a grommet for vertical connection of two building modules;

Figure 4b is a diagrammatic representation of a lifting hook;

Figure 5 is a perspective view of a corridor of the modular building, the corridor being shown partially cut-away and connected to a building module ;

Figure 6 is a perspective view of a two storey modular building in accordance with the present invention;

Figure 7 is an end view of a furbished corridor module with end walls removed for clarity;

Figure 8 is a schematic representation of an embodiment of a modular building of the present invention. showing a sewage system:

Figure 9 is a schematic representation of an embodiment of a modular building of the present invention showing an air conditioning system;

Figure 10 shows a diagrammatic layout of a modular office block building; and

Figure 11 shows a diagrammatic layout of a modular building forming a factory with offices.

Referring now to the drawings, figure 1 shows an exemplary modular building structure comprising a plurality of cabin modules 1 interconnected by corridors 2. The cabin modules 1 are designed to be furnished and used as, for example, offices or living quarters whereas the corridors 2 form passageways that, in addition to providing walkways between cabin modules 1, carry and distribute service supply

lines to the cabin modules 1. The building shown has multiple storeys that are interconnected by a stairwell 3 in the foreground.

For the purposes of clarity end walls of the cabin modules 1 and all corridor walls are not shown. The only parts of the corridor shown are the floors and ceilings (which are combined on intermediate storeys).

The building structure is assembled from the cabin modules 1 and corridors 2 using the known honeycomb principle in which there is no overall super-structure and the integral strength of the structure is shared by each module both laterally and vertically so that should one module fail the load is taken up by adjacent modules. It will be seen from the drawing of figure 1 that the cabin modules 1 can be of different sizes although they are of the same basic construction. The cabin and corridor modules 1,2 can be designed in a range of standard sizes to allow for different building types and configurations to be assembled from factory produced units. The corridors 2 have the same basic construction as the cabin modules 1 but are adapted to have different end sections and different below floor or above ceiling structures. The modules 1 are interconnected in a fashion that makes them easy to replace or exchange so that the building can be updated or regenerated at any time.

The modular structure of the building is ideally suited to office buildings, hotels. schools, light industrial sites as well as residential buildings. It is not at this stage intended for buildings of a more significant size such as large factories. warehouses, stadiums and theatres etc.

The present invention is concerned with the structure and method of construction of the building structure and the manner in which the cabin modules 1 are fastened together.

Each cabin module 1 comprises a tetragonal box assembly having top, bottom and side walls 4,5,6 and open ends 7. The module 1 may be constructed in a range of different heights. lengths and widths. The tetragonal structure provides strength without end walls being necessary and without the need for expensive superstructures or foundations.

Each cabin module 1 is fitted with an internal suspended ceiling and floor 8, 9 so as to define enclosed cavities 10, 11. The cavities 10, 11 accommodate service supplies, ventilation equipment, concealed lighting and other ancillary equipment.

Each cabin module 1 has a plurality of connection points 20 (see figure 2) disposed at regular intervals at the top and bottom of all four walls 4, 5, 6 and at open ends of the cabin. The connection points 20 permit adjacent cabin modules 1 to be connected together by fixing arrangements 21 (see figure 3) that are secured from inside the floor or ceiling cavities 10, 11 and are defined by housings 22 (one shown in figure 4) disposed in the floor and ceiling cavities 10, 11. Each housing 22 has a circular access chamber 23 that is open to the interior of the cabin and an elongate bore 24 extending radially from the access chamber 23 and out through a wall or an end frame of the cabin module 1. The fixing arrangement 21, shown in figure 3, comprises a double-headed fastening bolt 25 that carries a resilient but flexible grommet 26 of elastomeric material such as Neoprene or EPDM and two collars 27 each side of the grommet 26. In use the grommet 26 and bolt 25 extend into the aligned elongate bores 14 of the connection point housings 12 of adjacent cabin modules 1 so as to connect two cabin modules 1together. Figure 2shows the fixing arrangement 21 being used to connect together two cabin modules 1 side by side. The same arrangement is used to secure cabin modules 1 in vertical array, end-to-end or to connect corridor modules 2 to cabin modules 1. The open access chamber 23 of the housing 22 allows the fixing arrangement 21 to be easily inserted or removed.

Sub B3

The flexible and resilient nature of the grommet 26 permits adjacent cabin modules 1 to be coupled together without the requirement for their absolute alignment and without the fixing arrangement 21 becoming damaged or causing damage to the rest of the structure. This is essential for rapid construction of the building structure. Moreover, it allows easy reconfiguration, relocation or dismantling of the building structure. The fixing arrangement 21 provides primarily horizontal fixing strength but also partial vertical strength. The same connection point 20 and fixing arrangement 21 may be used to secure ancillary modules such as fire escapes, verandas stairwells etc. to the cabin or corridor modules.

It will be understood that the provision of multiple connection points 20 on each module permits selective use of those points that are appropriately positioned for each connection.

When cabin modules 1 are stacked on top of each other they are secured in a vertical direction by means of a half grommet fixing arrangement 30 that is fixed to the upper surface of the cabin module 1 or a supporting frame member.

Each grommet 30 is moulded, at one end. around a protruding metal screw 30a that engages in a threaded aperture 30b in the cabin module or frame member. The other end has an axial opening which securely receives a bolt 30c. A collar such as one of those shown in Figure 3 may be disposed on the bolt 30c.

The modules are lifted and placed on top of one another so that each half grommet fixing arrangement 30 is received in an aperture in the bottom wall of the cabin module 1 or supporting frame member above. The half grommet fixings 30 are then secured in place to an appropriate fixing plate via the collar under the floor cavity 8 of the cabin module 1 above by means of the bolt 30c.

Figure 4b illustrates that the half grommet fixing 30 interchangeable with a lifting eye 31 that can be secured to lifting tackle when the cabin modules 1 are to be moved.

The cabin and corridor modules 1. 2 of the building structure may be supported and secured against the elements by one of many different foundation structures, none of which is depicted here. The integral strength of the tetragonal structure renders it versatile of use with different foundation systems. For example. for medium and long term applications metal rings attached to jacking legs of the module may be placed in the ground and filled with concrete. Alternatively for soft or snow covered ground skids may be secured to the module with half grommet fixings. For swamp land. inland water and areas prone to flooding floatation rafts such as polystyrene blocks encapsulated in concrete surrounds are secured to the module with half grommet fixings. In environments where high wind pressure may be a problem the modules may be fitted with spreading bars that are secured to the module with half grommet connectors. The bars are generally in the form of angle irons submerged just

below ground surface, extending outwardly on each side of the module. These spreading bars may be used in conjunction with other foundation structures if necessary.

For smaller building structure complexes the gap between the modules and ground may enclosed by boarding and filled with polystyrene. This foundation may be of particular use in areas liable to flooding and also provides for an aesthetic finish. Whilst polystyrene is appropriate for light weight and quick response applications other forms of mineral in-fill may be used for different applications. The type of in-fill and the pressure of this fill is selected accordingly.

The advantage of such a foundation system is that it can be positioned directly on to most ground surfaces without the need for the ground surface to be completely flat or level; or for grass, or similar vegetation, to be removed.

The construction of such a foundation is effected in the following stages:

1. The first stage is necessary in applications where high wind conditions are possible.

Spreading bars are positioned just below the ground surface, and are adequately secured with ground screws or sinkers, etc., vertical grommet fastenings (extended in length) are screwed to the spreading bars at intervals corresponding to the bottom wall connection points.

2. A series of sausage shaped flotation bags (each bag extending as long as the width of the module, and approximately of a third of a meter in diameter, and being divided into separate internal chambers) are laid out across the site so that each module will be supported by at least two flotation bags.

Plastic hessian type sackings are laid between the flotation bags such that when expanded they are sufficiently large to fill the gap between two flotation bags.

3. Ground floor modules are then assembled in their designated formation, over the bags. and are temporarily supported on blocks, sufficient to allow the horizontal grommet fastenings between modules to be loosely engaged, and the extended vertical grommets to be positioned in the leg housing.

4. The floatation bags are then inflated (using an air pump equipped with a multiple outlet manifold and individual pressure gauges) sufficiently to lift the loose assembly gradually off the ground. Approximate levelling is achieved through adjusting the pressures in the appropriate chambers of the appropriate floatation bags.

Working from one end of the assembly to the other, the horizontal grommets are tightened into position, until the total assembly is secured into horizontal alignment.

The floating assembly can then be finally levelled, and raised or lowered to the desired height.

5. The plastic hessian type sackings, between the flotation bags, are then filled with expanding polystyrene foam, sufficient to fill cavities between the floatation bags, while temporary barriers prevent expansion outwards from the sides of the assembly. The expanding foam is applied in equal pressure in each sack (to a pressure less than that in the floatation bags).

6. After the foam has consolidated, the pressure in the floatation bags is then released and the modular assembly settles on to the polystyrene foundation

The floatation bags are deflated and pulled clear; after which the hollows that are left are filled with expanding polystyrene foam.

7. The vertical grommet bolts, securing the modules to the spreader bars, are tightened into position.

The upper stories of the building can then be assembled.

Finally, when the building is complete, the vertical grommets are re-tightened.

The advantage of this foundation system, over conventional footings, is seen in the difference in the speed and the cost construction. In addition the system, provides for improved insulation and, in view of the filling of the space under the modules, improved aesthetic value and security.

Figure 5 shows part of a corridor module 2 connected to a transversely disposed cabin module 1. The corridor 2 is represented partially cut-away so as to expose service supplies that are carried to each cabin module 1. As mentioned earlier,

the structure of the corridor 2 is the same as that described in relation to the cabin modules 1. In the ceiling cavity 11 there is an air conditioning plant 40 including conduits as shown at 41 and an electrical supply installation 42 and corresponding wiring 43. A domestic water supply and waste disposal system is carried in the floor cavity 10 as indicated at 44. The corridor modules 2 define walkways that extend across adjacent corridor modules 2 or between corridor 2 and cabin modules 1. Gaps between connected modules are bridged around the walkway area by flexible bellows-type walkway couplings 45.

An example of a two storey modular building structure is shown in Figure 6. The structure comprises two vertically stacked central corridor modules 2, each storey flanked by six cabin modules 1 (three on each side). The modules are interconnected horizontally by the fixing arrangements shown in Figure 2 and vertically by the half grommet fixings of Figure 4a.

In addition. horizontal grommet fixings extend between the edges of the open ends 7 of each module and the side wall of the corridor module 2.

A fully constructed and furbished corridor module is shown in figure 7 with the end shown open to expose the ceiling and floor cavities 10, 11.

An example of a waste disposal system for a building structure of the present invention is shown in figure 8. The system is shown in relation to a corridor comprising three axially joined corridor modules 2 and six cabin modules 1 connected on each side of the corridor 2. A service module 110 containing a suction pump and tank 111 is connected to an end of the corridor 2. Each corridor module 2 has a holding tank 112 in its floor cavity. Each tank 112 has flexible conduits 113 that are connected to a lavatory and wash area 114 of each cabin module 1 and adjacent holding tanks 112 are interconnected by a suction waste pipe 115. The figure also shows the flexible bellows coupling 95 between each corridor module 3 and between each cabin 1 and corridor module 2.

In figure 9. there is shown an exemplary air conditioning system depicted in relation to part of a building structure comprising a central corridor constructed from three axially connected corridor modules 2 and six cabin modules 1, three on each

side of the corridor 2. At one end of the corridor 2 there is a service module 120 containing a central plant 121 that feeds a heat exchanger 122 in the immediately adjacent corridor module 2. Further heat exchangers 122 are located in each corridor module 2, each heat exchanger 122 being connected to that of the adjacent corridor module 2 and to further heat exchangers 123 situated in each adjacent cabin module 2. An exhaust heat pump 124, connected to the corridor heat exchanger 122, is located outside each corridor module 2. Besides the central air conditioning plant the service module 121 may also contain central alarm and security control systems, service repair and spare equipment, telephone transmission and reception equipment, television reception apparatus. a fresh water distribution manifold, and, in the case of remotely located building structures. electrical generators.

Using corridors of this type it is possible to provide accommodation for short term applications without the need to provide pathways, foundations or to conduct preliminary ground excavation for drains and service supply lines. The investment generally made in creating such facilities are therefore not lost when relocating the building structure. The arrangement also enables building complexes to be sited on sloping or undulating sites without the need for gravity waste disposal. Any noisy equipment is conveniently located in the corridors leaving the cabin modules free of noise. vibration and clutter. The air conditioning also provides protection from outside interference (which is particularly desirable in noisy. dusty environments) as well as reducing condensation.

The standard cabin or corridor modules may be adapted as necessary depending on how they are to be used. For example, the corridor rooves may be made in a double-glassed construction to provide a conservatory. Ancillary structures such as. for example, fire escapes, balconies, canopies and exterior walkways may be connected to the modules by the grommet fixing arrangements described above.

The modular nature of the corridor and cabin modules means that many different building layouts are possible. Examples are shown in figures 10 and 11. The former shows a layout an office block having a first corridor 130 with three office cabin modules 131 on one side and four cabin modules 132 on the other side

designated for three smaller offices and a pantry. One end of the first corridor module 130 meets a transversely extending second corridor module 133 which is connected to four cabin modules 134 that are furbished as toilets, a reception area, and a service module with store.

In figure 11 there is shown an example layout for a factory with offices. A central corridor 140 comprising two modules interconnects a demonstration and show room 141 comprising two side-by-side cabin modules at one end and a workshop area 142 comprising five side-by-side cabin modules at the other end of the corridor 140. Cabin modules 143 of various sizes connect to the corridor on each side and are furbished as offices, lavatories, a service modules and a pantry. The workshop area 142 is connected to three cabin modules defining a delivery area 144.

Broadly speaking the on-site procedure for constructing a building of this type is as follows:

a) the service module is delivered to the site and placed in the correct location;

b) the foundations are laid down with access roads, car parking, boundary fences etc.;

c) the cabin modules and corridor modules are delivered and secured to the foundations and to each other; and

d) the mains service supplies are routed from the service module along the corridor floor and ceiling cavities through to the cabin modules and the building is tested for occupation.

The building structures of the present invention differ from previous prefabricated buildings in that they are manufactured in their entirety in modular format together with completed interiors. The buildings are comparatively lightweight, do not have an overall superstructure and require only limited foundations. In view of the modular structure the on-site construction is less complicated and more rapid that conventional buildings. The range of module sizes allows for all buildings to be assembled from factory produced units.

The open-ended tetragonal structure of each module can be fitted with a choice of standard end sections that serve to determine the module identity and purpose e.g a

compartment module, a corridor module, a container etc. The simple tetragonal cabin module is transformed into a number of mutations by mixing a range of standard modules with a range of standard end sections, as above. These modules can then be combined together into different formations to produce buildings that are all uniquely different.

The integrity of individual modules combined into the cumulative strength of honeycomb building, is further aided by the foam cushioning foundations and the elasticity tolerance in the inter modular fastening. The honeycomb structure in comparison to bricks and mortar, or iron frame construction, is less prone to collapse. If sections of honeycomb buildings are destroyed then the remaining structure can provide sufficient support to maintain the rest of the building in situ.

One of the main advantages is the considerable cost reduction for manufacturing buildings of this kind. A considerable quantity of variable applications can be constructed from comparatively few basic building blocks. The system provides factory finished interiors and internal services which are generally of a higher quality and cheaper to produce than those constructed on-site. The speed and simplicity with which the honeycomb structure building can be erected dramatically reduces the construction time and costs. In addition there is a significant reduction in pre-building costs such as those expended in employing architects, surveyors, site management etc.

The construction of the cabins is suitable for mass production giving both labour and materials cost advantages. The different sizes of module produced by using differing dimensions of the same product means and incorporating different end sections that many different markets can be supplied without creating the need for different manufacturing processes.

Bare cabins (with the floor, ceiling and end sections fitted) can be delivered to special outfitters where they are furbished before being transported to the construction site.

Transportation of the modules is simplified as they are lightweight and strong enabling them to be placed and moved on a lightweight trailer rather than a heavy

duty vehicle. The structure of the modules is such that they can be transported on their sides if necessary. The modules are also suitable for air transport to inaccessible locations or in military applications or circumstances where a quick response in required (e.g. emergencies such as natural disasters).

Once built, the building structure can later be modified, expanded or reconfigured to suit changing requirements relatively simply. In addition, the building structure can be relocated in whole or in part with ease.

Since the component modules are of standard design, the building structure lends itself well to simple computer modelling and virtual reality systems that enable layout planning. The simplicity would also enable the end user of the building to participate in the design of the building.

The modular nature of the building enables it to be enlarged or reduced in size as appropriate. This may have advantage for both the residential and commercial market. For example, first time residential buyers will be able to start with a small one bedroom house, expand the size of the building over time by adding extra modules as the family grows and reduce the size of the building by removing modules as the family size diminishes. The style of the house can be constructed to suit the owner's preferences. Similarly, in the commercial realm the size of the building can be varied throughout its life to reflect the growth or diminishing size of the business.

Similarly, disused modular buildings can be dismantled and removed so that ugly, dilapidated or vandalised buildings can be quickly removed. A minimum disturbance to land structure means that land can be returned to green site conditions after the buildings have been removed

Valuing property for sale or financing purposes is simplified in that the value of the property is no longer restricted by its location and design and can be easily assessed by the aggregate value of its component parts while the site is valued separately in terms of size and location.

The present invention provides for improved durability in prefabricated buildings of about 40 years with a higher standard of interiors and internal services as compared to the 15 years for existing structures.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
DE/J088190PWO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 99/02141	05/07/1999	03/07/1998
Applicant		
MARSH, Peter, Gordon		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[ ] the text is approved as submitted by the applicant.

[X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[ ] as suggested by the applicant.

[X] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

line 1, add "(2)" after "corridor" ,
line 2, add "(1)" after "modules" ,
line 7, add "(26)" after "grommet" .

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/02141

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B1/348

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 32 26 742 A (DIETRICH RICHARD DIPL ING) 19 January 1984 (1984-01-19) page 9, line 16 -page 13, line 23; figures 1,2	1,2,5,23 7,10,13, 15,24
X	US 3 742 666 A (ANTONIOU A) 3 July 1973 (1973-07-03) the whole document	1,15
A	GB 1 493 802 A (PORTAKABIN LTD) 30 November 1977 (1977-11-30) the whole document	1,12,17, 21,25
A	DE 32 29 881 A (INTERATOM) 16 February 1984 (1984-02-16) the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1999	22/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Vrugt, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/02141

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3226742 A	19-01-1984	NONE	
US 3742666 A	03-07-1973	AU 4541672 A	14-02-1974
		CA 955186 A	24-09-1974
		DE 2242274 A	22-03-1973
		FR 2152156 A	20-04-1973
		IT 986030 B	10-01-1975
		JP 48036927 A	31-05-1973
GB 1493802 A	30-11-1977	NONE	
DE 3229881 A	16-02-1984	NONE	

15

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
DE/J088190PWO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/02141	05/07/1999	03/07/1998
International Patent Classification (IPC) or national classification and IPC E04B1/348		
Applicant MARSH, Peter, Gordon		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/02/2000	12.10.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Rosborough, J Telephone No. +49 89 2399 2818

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/02141

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

4-14	as originally filed			
1-3	as received on	18/07/2000	with letter of	13/07/2000

Claims, No.:

1-21	as received on	18/07/2000	with letter of	13/07/2000

Drawings, sheets:

1/9-9/9	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☒ the claims, Nos.: 22-25
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

see separate sheet

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-21
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item IV

Lack of unity of invention

Unity of invention (Rule 13.1 PCT) does not exist between the subject-matter of the following groups of independent claims because a technical relationship involving one or more of the same or corresponding special technical features in the sense of Rule 13.2 PCT is not present.

The separate inventions and their respective special technical feature(s) are as follows:

Invention A):	Claims 1 and 14	Special technical features - the service module defining a plurality of connection nodes and being in the form of / furnished such that it is in the form of a corridor walkway linking the building modules.
Invention B):	Claim 16	Apparatus for connecting building modules Special technical features - a flexible resilient insert inserted in an aperture in one building module, said insert being attached to an adjacent module and supported on a fixing element that is secured to said adjacent building module.

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US-A-3,742,666
D2: DE-A-32 26 742
D3: GB-A-1 493 802.

5.1 Independent Claim 1.

Document D1, which is considered to represent the most relevant state of the art, discloses:
- a modular building structure comprising a service module (fig.1, (17)) defining a plurality of connection nodes (fig.5, (124-127, 134) or fig.1 (133,150)) for connection to separate building modules (fig.1, (18-20),
- the service module containing apparatus for the supply and distribution of at least one mains service to the building modules,
- each building module being free-standing, pre-fitted for its intended use (column 3, lines 5-10, and fig.11) and connected to one of said connection nodes and to said supply of at least one mains service.

from which the subject-matter of claim 1 differs in that:
- the service module is in the form of a corridor walkway linking the building modules.

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT).

The problem to be solved by the present invention may therefore be regarded as:
to provide a corridor for the building structure of D1.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT), as D1 teaches the construction of the service module to be as compact as possible (column 1, lines 58-62 and figs.), and provides no indication to extend said module so that it provides a corridor walkway linking the building modules.

Document D2 discloses (cf. fig.1 and figs. 4 and 5, (61)) a service module in the form of a room, particularly a bathroom. It provides no indication to provide said service module in the form of a corridor walkway.
Moreover D2 does not disclose either separate building modules or connection nodes for the connection of the service module to said building modules.

5.2 Independent Claim 14.

Independent claim 14 is directed to a method for constructing a modular building structure. For the reasons provides under item 5.1, the subject-matter of claim 14 also conforms to the requirements of Articles 33(2) and (3) PCT.

5.3 Independent Claim 16.

Document D3, which is considered to represent the most relevant state of the art, discloses an apparatus for connecting adjacent building modules.
Neither D3, nor any of the remaining available prior art documents either discloses or provides an indication for the remaining features of claim 16.
The subject-matter of claim 1 therefore conforms to the requirements of Articles 33(2) and (3) PCT.

5.4 Dependent Claims 2-13; 15; and 17-21.

Claims 2-13; 15; and 17-21 are dependent on claims 1; 14; and 16 respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VII
Certain defects in the international application

7.1 Two-Part Form.
The claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document D1) being placed in a preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in a characterising part (Rule 6.3(b)(ii) PCT).

7.2 Reference Signs.
The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

Certain observations on the international application

8.1 Description.

According to the requirements of Rule 11.13(l) reference signs not appearing in the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference signs (26) and (27), referred to on page 6, line 14 and the reference to a "collar" on page 7, lines 9 and 10.

MODULAR BUILDINGS

The present invention relates to modular buildings and more particularly to their structure, the method of their construction and interconnection.

It is well known to provide for portable modular building in circumstances where accommodation is needed in an emergency or on a temporary basis. Such buildings have to be rapidly and easily assembled to meet demand for emergency habitable structures in times, for example, of natural or other disasters. In addition such buildings are often required in remote locations by workers employed in the construction industry where temporary accommodation is needed during the term of the construction project.

There is a need for an all-purpose modular building system that can be exploited by both the residential and commercial construction sectors of industry. To date, portable and prefabricated buildings designs have not proved suitable for application in both sectors. Modular buildings have the advantages that they are easy and quick to erect, dismantle or relocate, are readily transportable, and flexible in that they are reconfigurable to meet changing requirements in size or needs. Unfortunately existing designs of such buildings are generally of a temporary nature and are not suited to long-term or permanent applications.

Existing modular buildings suffer from several disadvantages including: racking which causes wear and tear to the structure of the building and often leads to leaks, creaks and structural damage; condensation; inadequate interior temperature control; ineffective noise insulation; and an excessive ingress of dirt and dust (particularly in environments such as construction sites).

US-A-3742666 describes a modular building construction in which a pre-fabricated module for utility supply systems such modules can be delivered in a pre-fitted state to the construction site and assembled with limited effort and time. The module has side wall openings by which it may be attached to building modules.

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages and to provide for a modular building construction that has improved life expectancy so that it meets the requirements of more permanent structures whilst

maintaining the benefits of its modular nature. The term "building module" is used hereinafter to refer to an inhabitable building block that can be used as living quarters, an office, a conference room, a lavatory or washroom or another room that forms part of a larger building structure.

According to a first aspect of the present invention there is provided a modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.

The modular structure of the present invention provides for a very flexible arrangement in that once the service module has been installed on site the building modules can then be connected thereto in the desired number and fashion. If there is a demand for more building modules these can be simply added without the need to lay further mains service supplies. Similarly, removal of a particular building module is also a simple operation. As the mains service supply is contained within the service module the need for preliminary ground excavation is eliminated. Moreover little or no foundations are required.

The corridor may conveniently be provided with floor and ceiling cavities in which the mains service supplies are routed. Preferably one building module is a dedicated plant room that feeds the mains supply service to the service module.

The service module is preferably sectional so that it can be extended or shortened to provide more or less connection nodes as required. More than one service module may be provided and they may extend in transverse directions. The mains service may be electricity, waste disposal, air conditioning, water etc. In the case of waste disposal, each service module is provided with a holding tank and is connected to a lavatory or wash area of an adjacent building module. Preferably the holding tanks of adjacent sections of a service module are connected by a suction waste pipe.

The arrangement eliminates the need for gravity operated waste disposal. In the case of air conditioning each service module is preferably fitted with a heat exchanger and has an external pump for evacuation of warm air. Each building module also has its own heat exchanger that is connected to the pump and heat exchanger of the adjacent service module.

Preferably each adjoining pair of building modules or service modules have apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

According to a second aspect of the present invention there is provided a method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

According to a third aspect of the present invention there is provided an apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being that is received in the aperture and supported on a fixing element that is secured to said adjacent building module.

The housing preferably further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

Preferably the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

Specific embodiments of the present inventions will now be described, by way of example only, with reference to the accompanying drawings in which:

CLAIMS

1. A modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.

2. A modular building structure according to claim 1, wherein each module is an open-ended box configuration.

3. A modular building structure according to claims 1 or 2, wherein the service module has floor and ceiling cavities in which the mains service supplies are routed.

4. A modular building structure according to any one of claims 1 to 3, wherein one building module is a dedicated plant room that feeds the mains supply service to the service module.

5. A modular building structure according to any preceding claim, wherein the service module is sectional so that it can be extended or shortened to provide more or less connection nodes as required.

6. A modular building structure according to any preceding claim wherein there is provided a plurality of service modules, some modules being disposed in a direction transverse to others.

7. A modular building structure according to claim 6, wherein the mains service is for waste disposal and each service module is provided with a holding tank that is connected to a lavatory or wash area of an adjacent building module.

8. A modular building structure according to claim 7, wherein holding tanks of adjacent service modules are connected by a suction waste pipe.

9. A modular building structure according to any preceding claim, wherein the mains service supply is air conditioning and each service module is fitted with a heat exchanger and has an external pump for evacuation of warm air.

10. A modular building structure according to claim 9, wherein each building module also has its own heat exchanger that is connected to the pump and heat exchanger of an adjacent service module.

11. A modular building structure according to any preceding claim, wherein each adjoining pair of building modules or service modules has apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is snugly received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

12. A modular building structure according to any preceding claim, comprising multiple storeys, vertically adjacent modules being connected by a connecting member comprising a resilient flexible insert attached to one module and received in an aperture of the vertically adjacent module.

13. A modular building structure according to any preceding claim, wherein the modules are connected to a foundation of foamed mineral in-fill.

14. A method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

15. A method according to claim 14, comprising further steps of filling a clearance between the module and ground with a foundation of foamed mineral in-fill.

16. Apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being received in the aperture and supported on a fixing element that is secured to said adjacent building module.

17. Apparatus according to claim 16, wherein each horizontally adjacent module has an aperture, the flexible resilient insert is received in each aperture and bridges the two building modules.

18. Apparatus according to claim 16, wherein the modules are vertically adjacent, one of the modules having projecting therefrom said resilient flexible insert and the other having said aperture.

19. Apparatus according to claims 17 or 18, wherein the housing further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

20. Apparatus according to claim any one of claims 16 to 19, wherein the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

21. Apparatus according to any one of claims 16 to 20, wherein the insert is a grommet.

add A1

add B1 > add B2

PCT

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(71)(72) Applicant and Inventor: MARSH, Peter, Gordon [GB/GB]; 33 Hopwood Avenue, Hopwood, Heywood OL10 2AX (GB).

(74) Agent: EVERY, David, Aidan; Marks & Clerk, Sussex House, 83–85 Mosley Street, Manchester M2 3LG (GB).

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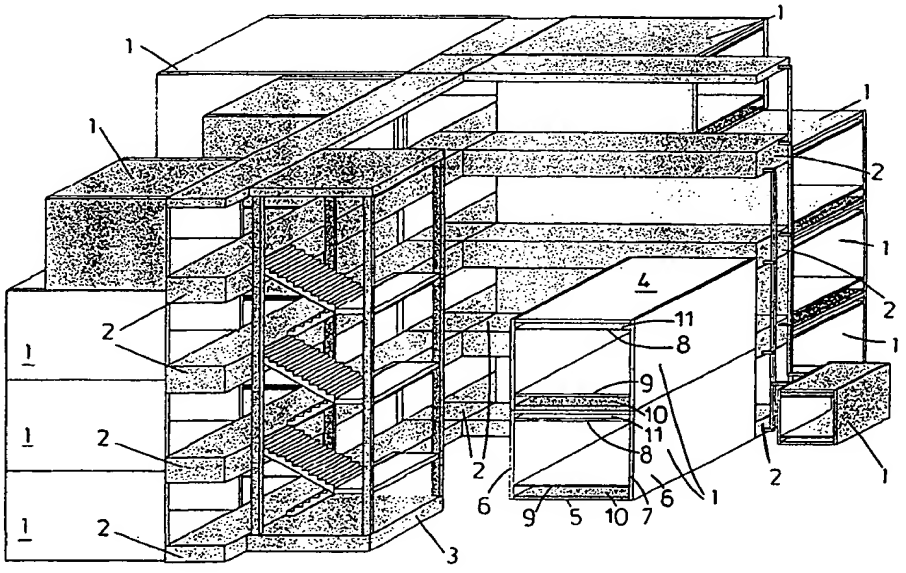

(57) Abstract

A modular building structure comprises a service corridor (2) to which are connected separate cabin modules (1) that form accommodation or offices etc. The service module contains apparatus for the supply and distribution of mains services such as water, electricity, waste disposal and air conditioning to the building modules. The modules are connected to the corridor and to said mains supply services. Each of the cabin modules is free–standing, pre–fitted for its intended use. Adjacent modules are interconnected by a flexible grommet (26) that extends between aligned apertures in each module.

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MODULAR BUILDINGS

The present invention relates to modular buildings and more particularly to their structure, the method of their construction and interconnection.

It is well known to provide for portable modular building in circumstances where accommodation is needed in an emergency or on a temporary basis. Such buildings have to be rapidly and easily assembled to meet demand for emergency habitable structures in times, for example, of natural or other disasters. In addition such buildings are often required in remote locations by workers employed in the construction industry where temporary accommodation is needed during the term of the construction project.

There is a need for an all-purpose modular building system that can be exploited by both the residential and commercial construction sectors of industry. To date, portable and prefabricated buildings designs have not proved suitable for application in both sectors. Modular buildings have the advantages that they are easy and quick to erect, dismantle or relocate, are readily transportable, and flexible in that they are reconfigurable to meet changing requirements in size or needs. Unfortunately existing designs of such buildings are generally of a temporary nature and are not suited to long-term or permanent applications.

Existing modular buildings suffer from several disadvantages including: racking which causes wear and tear to the structure of the building and often leads to leaks, creaks and structural damage; condensation; inadequate interior temperature control; ineffective noise insulation; and an excessive ingress of dirt and dust (particularly in environments such as construction sites).

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages and to provide for a modular building construction that has improved life expectancy so that it meets the requirements of more permanent structures whilst maintaining the benefits of its modular nature. The term "building module" is used hereinafter to refer to an inhabitable building block that can be used as living quarters, an office, a conference room, a lavatory or washroom or another room that forms part of a larger building structure.

According to a first aspect of the present invention there is provided a modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service.

The modular structure of the present invention provides for a very flexible arrangement in that once the service module has been installed on site the building modules can then be connected thereto in the desired number and fashion. If there is a demand for more building modules these can be simply added without the need to lay further mains service supplies. Similarly, removal of a particular building module is also a simple operation. As the mains service supply is contained within the service module the need for preliminary ground excavation is eliminated. Moreover little or no foundations are required.

The service module is preferably in the form of a corridor walkway linking the building modules. The corridor may conveniently be provided with floor and ceiling cavities in which the mains service supplies are routed. Preferably one building module is a dedicated plant room that feeds the mains supply service to the service module.

The service module is preferably sectional so that it can be extended or shortened to provide more or less connection nodes as required. More than one service module may be provided and they may extend in transverse directions. The mains service may be electricity, waste disposal, air conditioning, water etc. In the case of waste disposal, each service module is provided with a holding tank and is connected to a lavatory or wash area of an adjacent building module. Preferably the holding tanks of adjacent sections of a service module are connected by a suction waste pipe. The arrangement eliminates the need for gravity operated waste disposal. In the case of air conditioning each service module is preferably fitted with a heat exchanger and has an external pump for evacuation of warm air. Each building module also has its

own heat exchanger that is connected to the pump and heat exchanger of the adjacent service module.

Preferably each adjoining pair of building modules or service modules have apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

According to a second aspect of the present invention there is provided a method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting it to the mains supply service of the service module.

According to a third aspect of the present invention there is provided an apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being that is received in the aperture and supported on a fixing element that is secured to said adjacent building module.

The housing preferably further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

Preferably the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

Specific embodiments of the present inventions will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a modular building structure of the present invention constructed from a plurality of interconnected modules with certain panels removed for clarity;

Figure 2 is a sectioned side view of the intersection of two modules showing connecting points and a fixing assembly;

Figure 3 is a side view of a grommet of the fixing assembly shown in figure 2;

Figure 4 is a side view of a grommet housing of the connecting point shown in figure 2;

Figure 4a is a diagrammatic representation of a grommet for vertical connection of two building modules;

Figure 4b is a diagrammatic representation of a lifting hook;

Figure 5 is a perspective view of a corridor of the modular building, the corridor being shown partially cut-away and connected to a building module ;

Figure 6 is a perspective view of a two storey modular building in accordance with the present invention;

Figure 7 is an end view of a furbished corridor module with end walls removed for clarity;

Figure 8 is a schematic representation of an embodiment of a modular building of the present invention, showing a sewage system:

Figure 9 is a schematic representation of an embodiment of a modular building of the present invention showing an air conditioning system;

Figure 10 shows a diagrammatic layout of a modular office block building; and

Figure 11 shows a diagrammatic layout of a modular building forming a factory with offices.

Referring now to the drawings, figure 1 shows an exemplary modular building structure comprising a plurality of cabin modules 1 interconnected by corridors 2. The cabin modules 1 are designed to be furnished and used as, for example, offices or living quarters whereas the corridors 2 form passageways that, in addition to providing walkways between cabin modules 1, carry and distribute service supply

lines to the cabin modules 1. The building shown has multiple storeys that are interconnected by a stairwell 3 in the foreground.

For the purposes of clarity end walls of the cabin modules 1 and all corridor walls are not shown. The only parts of the corridor shown are the floors and ceilings (which are combined on intermediate storeys).

The building structure is assembled from the cabin modules 1 and corridors 2 using the known honeycomb principle in which there is no overall super-structure and the integral strength of the structure is shared by each module both laterally and vertically so that should one module fail the load is taken up by adjacent modules. It will be seen from the drawing of figure 1 that the cabin modules 1 can be of different sizes although they are of the same basic construction. The cabin and corridor modules 1,2 can be designed in a range of standard sizes to allow for different building types and configurations to be assembled from factory produced units. The corridors 2 have the same basic construction as the cabin modules 1 but are adapted to have different end sections and different below floor or above ceiling structures. The modules 1 are interconnected in a fashion that makes them easy to replace or exchange so that the building can be updated or regenerated at any time.

The modular structure of the building is ideally suited to office buildings, hotels, schools, light industrial sites as well as residential buildings. It is not at this stage intended for buildings of a more significant size such as large factories, warehouses, stadiums and theatres etc.

The present invention is concerned with the structure and method of construction of the building structure and the manner in which the cabin modules 1 are fastened together.

Each cabin module 1 comprises a tetragonal box assembly having top, bottom and side walls 4,5,6 and open ends 7. The module 1 may be constructed in a range of different heights, lengths and widths. The tetragonal structure provides strength without end walls being necessary and without the need for expensive superstructures or foundations.

Each cabin module 1 is fitted with an internal suspended ceiling and floor 8, 9 so as to define enclosed cavities 10, 11. The cavities 10, 11 accommodate service supplies, ventilation equipment, concealed lighting and other ancillary equipment.

Each cabin module 1 has a plurality of connection points 20 (see figure 2) disposed at regular intervals at the top and bottom of all four walls 4, 5, 6 and at open ends of the cabin. The connection points 20 permit adjacent cabin modules 1 to be connected together by fixing arrangements 21 (see figure 3) that are secured from inside the floor or ceiling cavities 10, 11 and are defined by housings 22 (one shown in figure 4) disposed in the floor and ceiling cavities 10, 11. Each housing 22 has a circular access chamber 23 that is open to the interior of the cabin and an elongate bore 24 extending radially from the access chamber 23 and out through a wall or an end frame of the cabin module 1. The fixing arrangement 21, shown in figure 3, comprises a double-headed fastening bolt 25 that carries a resilient but flexible grommet 26 of elastomeric material such as Neoprene or EPDM and two collars 27 each side of the grommet 26. In use the grommet 26 and bolt 25 extend into the aligned elongate bores 14 of the connection point housings 12 of adjacent cabin modules 1 so as to connect two cabin modules 1together. Figure 2shows the fixing arrangement 21 being used to connect together two cabin modules 1 side by side. The same arrangement is used to secure cabin modules 1 in vertical array, end-to-end or to connect corridor modules 2 to cabin modules 1. The open access chamber 23 of the housing 22 allows the fixing arrangement 21 to be easily inserted or removed.

The flexible and resilient nature of the grommet 26 permits adjacent cabin modules 1 to be coupled together without the requirement for their absolute alignment and without the fixing arrangement 21 becoming damaged or causing damage to the rest of the structure. This is essential for rapid construction of the building structure. Moreover, it allows easy reconfiguration, relocation or dismantling of the building structure. The fixing arrangement 21 provides primarily horizontal fixing strength but also partial vertical strength. The same connection point 20 and fixing arrangement 21 may be used to secure ancillary modules such as fire escapes, verandas stairwells etc. to the cabin or corridor modules.

It will be understood that the provision of multiple connection points 20 on each module permits selective use of those points that are appropriately positioned for each connection.

When cabin modules 1 are stacked on top of each other they are secured in a vertical direction by means of a half grommet fixing arrangement 30 that is fixed to the upper surface of the cabin module 1 or a supporting frame member.

Each grommet 30 is moulded, at one end, around a protruding metal screw 30a that engages in a threaded aperture 30b in the cabin module or frame member. The other end has an axial opening which securely receives a bolt 30c. A collar such as one of those shown in Figure 3 may be disposed on the bolt 30c.

The modules are lifted and placed on top of one another so that each half grommet fixing arrangement 30 is received in an aperture in the bottom wall of the cabin module 1 or supporting frame member above. The half grommet fixings 30 are then secured in place to an appropriate fixing plate via the collar under the floor cavity 8 of the cabin module 1 above by means of the bolt 30c.

Figure 4b illustrates that the half grommet fixing 30 interchangeable with a lifting eye 31 that can be secured to lifting tackle when the cabin modules 1 are to be moved.

The cabin and corridor modules 1, 2 of the building structure may be supported and secured against the elements by one of many different foundation structures, none of which is depicted here. The integral strength of the tetragonal structure renders it versatile of use with different foundation systems. For example, for medium and long term applications metal rings attached to jacking legs of the module may be placed in the ground and filled with concrete. Alternatively for soft or snow covered ground skids may be secured to the module with half grommet fixings. For swamp land, inland water and areas prone to flooding floatation rafts such as polystyrene blocks encapsulated in concrete surrounds are secured to the module with half grommet fixings. In environments where high wind pressure may be a problem the modules may be fitted with spreading bars that are secured to the module with half grommet connectors. The bars are generally in the form of angle irons submerged just

below ground surface, extending outwardly on each side of the module. These spreading bars may be used in conjunction with other foundation structures if necessary.

For smaller building structure complexes the gap between the modules and ground may enclosed by boarding and filled with polystyrene. This foundation may be of particular use in areas liable to flooding and also provides for an aesthetic finish. Whilst polystyrene is appropriate for light weight and quick response applications other forms of mineral in-fill may be used for different applications. The type of in-fill and the pressure of this fill is selected accordingly.

The advantage of such a foundation system is that it can be positioned directly on to most ground surfaces without the need for the ground surface to be completely flat or level; or for grass, or similar vegetation, to be removed.

The construction of such a foundation is effected in the following stages:

1. The first stage is necessary in applications where high wind conditions are possible.

Spreading bars are positioned just below the ground surface, and are adequately secured with ground screws or sinkers, etc., vertical grommet fastenings (extended in length) are screwed to the spreading bars at intervals corresponding to the bottom wall connection points.

2. A series of sausage shaped flotation bags (each bag extending as long as the width of the module, and approximately of a third of a meter in diameter, and being divided into separate internal chambers) are laid out across the site so that each module will be supported by at least two flotation bags.

Plastic hessian type sackings are laid between the flotation bags such that when expanded they are sufficiently large to fill the gap between two flotation bags.

3. Ground floor modules are then assembled in their designated formation, over the bags, and are temporarily supported on blocks, sufficient to allow the horizontal grommet fastenings between modules to be loosely engaged, and the extended vertical grommets to be positioned in the leg housing.

4. The floatation bags are then inflated (using an air pump equipped with a multiple outlet manifold and individual pressure gauges) sufficiently to lift the loose assembly gradually off the ground. Approximate levelling is achieved through adjusting the pressures in the appropriate chambers of the appropriate floatation bags.

Working from one end of the assembly to the other, the horizontal grommets are tightened into position, until the total assembly is secured into horizontal alignment.

The floating assembly can then be finally levelled, and raised or lowered to the desired height.

5. The plastic hessian type sackings, between the flotation bags, are then filled with expanding polystyrene foam, sufficient to fill cavities between the floatation bags, while temporary barriers prevent expansion outwards from the sides of the assembly. The expanding foam is applied in equal pressure in each sack (to a pressure less than that in the floatation bags).

6. After the foam has consolidated, the pressure in the floatation bags is then released and the modular assembly settles on to the polystyrene foundation

The floatation bags are deflated and pulled clear; after which the hollows that are left are filled with expanding polystyrene foam.

7. The vertical grommet bolts, securing the modules to the spreader bars, are tightened into position.

The upper stories of the building can then be assembled.

Finally, when the building is complete, the vertical grommets are re-tightened.

The advantage of this foundation system, over conventional footings, is seen in the difference in the speed and the cost construction. In addition the system. provides for improved insulation and. in view of the filling of the space under the modules, improved aesthetic value and security.

Figure 5 shows part of a corridor module 2 connected to a transversely disposed cabin module 1. The corridor 2 is represented partially cut-away so as to expose service supplies that are carried to each cabin module 1. As mentioned earlier,

the structure of the corridor 2 is the same as that described in relation to the cabin modules 1. In the ceiling cavity 11 there is an air conditioning plant 40 including conduits as shown at 41 and an electrical supply installation 42 and corresponding wiring 43. A domestic water supply and waste disposal system is carried in the floor cavity 10 as indicated at 44. The corridor modules 2 define walkways that extend across adjacent corridor modules 2 or between corridor 2 and cabin modules 1. Gaps between connected modules are bridged around the walkway area by flexible bellows-type walkway couplings 45.

An example of a two storey modular building structure is shown in Figure 6. The structure comprises two vertically stacked central corridor modules 2, each storey flanked by six cabin modules 1 (three on each side). The modules are interconnected horizontally by the fixing arrangements shown in Figure 2 and vertically by the half grommet fixings of Figure 4a.

In addition, horizontal grommet fixings extend between the edges of the open ends 7 of each module and the side wall of the corridor module 2.

A fully constructed and furbished corridor module is shown in figure 7 with the end shown open to expose the ceiling and floor cavities 10, 11.

An example of a waste disposal system for a building structure of the present invention is shown in figure 8. The system is shown in relation to a corridor comprising three axially joined corridor modules 2 and six cabin modules 1 connected on each side of the corridor 2. A service module 110 containing a suction pump and tank 111 is connected to an end of the corridor 2. Each corridor module 2 has a holding tank 112 in its floor cavity. Each tank 112 has flexible conduits 113 that are connected to a lavatory and wash area 114 of each cabin module 1 and adjacent holding tanks 112 are interconnected by a suction waste pipe 115. The figure also shows the flexible bellows coupling 95 between each corridor module 3 and between each cabin 1 and corridor module 2.

In figure 9, there is shown an exemplary air conditioning system depicted in relation to part of a building structure comprising a central corridor constructed from three axially connected corridor modules 2 and six cabin modules 1, three on each

side of the corridor 2. At one end of the corridor 2 there is a service module 120 containing a central plant 121 that feeds a heat exchanger 122 in the immediately adjacent corridor module 2. Further heat exchangers 122 are located in each corridor module 2, each heat exchanger 122 being connected to that of the adjacent corridor module 2 and to further heat exchangers 123 situated in each adjacent cabin module 2. An exhaust heat pump 124, connected to the corridor heat exchanger 122, is located outside each corridor module 2. Besides the central air conditioning plant the service module 121 may also contain central alarm and security control systems, service repair and spare equipment, telephone transmission and reception equipment, television reception apparatus, a fresh water distribution manifold, and, in the case of remotely located building structures, electrical generators.

Using corridors of this type it is possible to provide accommodation for short term applications without the need to provide pathways, foundations or to conduct preliminary ground excavation for drains and service supply lines. The investment generally made in creating such facilities are therefore not lost when relocating the building structure. The arrangement also enables building complexes to be sited on sloping or undulating sites without the need for gravity waste disposal. Any noisy equipment is conveniently located in the corridors leaving the cabin modules free of noise, vibration and clutter. The air conditioning also provides protection from outside interference (which is particularly desirable in noisy, dusty environments) as well as reducing condensation.

The standard cabin or corridor modules may be adapted as necessary depending on how they are to be used. For example, the corridor rooves may be made in a double-glassed construction to provide a conservatory. Ancillary structures such as, for example, fire escapes, balconies, canopies and exterior walkways may be connected to the modules by the grommet fixing arrangements described above.

The modular nature of the corridor and cabin modules means that many different building layouts are possible. Examples are shown in figures 10 and 11. The former shows a layout an office block having a first corridor 130 with three office cabin modules 131 on one side and four cabin modules 132 on the other side

designated for three smaller offices and a pantry. One end of the first corridor module 130 meets a transversely extending second corridor module 133 which is connected to four cabin modules 134 that are furbished as toilets, a reception area, and a service module with store.

In figure 11 there is shown an example layout for a factory with offices. A central corridor 140 comprising two modules interconnects a demonstration and show room 141 comprising two side-by-side cabin modules at one end and a workshop area 142 comprising five side-by-side cabin modules at the other end of the corridor 140. Cabin modules 143 of various sizes connect to the corridor on each side and are furbished as offices, lavatories, a service modules and a pantry. The workshop area 142 is connected to three cabin modules defining a delivery area 144.

Broadly speaking the on-site procedure for constructing a building of this type is as follows:

a) the service module is delivered to the site and placed in the correct location;

b) the foundations are laid down with access roads, car parking, boundary fences etc.;

c) the cabin modules and corridor modules are delivered and secured to the foundations and to each other; and

d) the mains service supplies are routed from the service module along the corridor floor and ceiling cavities through to the cabin modules and the building is tested for occupation.

The building structures of the present invention differ from previous prefabricated buildings in that they are manufactured in their entirety in modular format together with completed interiors. The buildings are comparatively lightweight, do not have an overall superstructure and require only limited foundations. In view of the modular structure the on-site construction is less complicated and more rapid that conventional buildings. The range of module sizes allows for all buildings to be assembled from factory produced units.

The open-ended tetragonal structure of each module can be fitted with a choice of standard end sections that serve to determine the module identity and purpose e.g a

compartment module, a corridor module, a container etc. The simple tetragonal cabin module is transformed into a number of mutations by mixing a range of standard modules with a range of standard end sections, as above. These modules can then be combined together into different formations to produce buildings that are all uniquely different.

The integrity of individual modules combined into the cumulative strength of honeycomb building, is further aided by the foam cushioning foundations and the elasticity tolerance in the inter modular fastening. The honeycomb structure in comparison to bricks and mortar, or iron frame construction, is less prone to collapse. If sections of honeycomb buildings are destroyed then the remaining structure can provide sufficient support to maintain the rest of the building in situ.

One of the main advantages is the considerable cost reduction for manufacturing buildings of this kind. A considerable quantity of variable applications can be constructed from comparatively few basic building blocks. The system provides factory finished interiors and internal services which are generally of a higher quality and cheaper to produce than those constructed on-site. The speed and simplicity with which the honeycomb structure building can be erected dramatically reduces the construction time and costs. In addition there is a significant reduction in pre-building costs such as those expended in employing architects, surveyors, site management etc.

The construction of the cabins is suitable for mass production giving both labour and materials cost advantages. The different sizes of module produced by using differing dimensions of the same product means and incorporating different end sections that many different markets can be supplied without creating the need for different manufacturing processes.

Bare cabins (with the floor, ceiling and end sections fitted) can be delivered to special outfitters where they are furbished before being transported to the construction site.

Transportation of the modules is simplified as they are lightweight and strong enabling them to be placed and moved on a lightweight trailer rather than a heavy

duty vehicle. The structure of the modules is such that they can be transported on their sides if necessary. The modules are also suitable for air transport to inaccessible locations or in military applications or circumstances where a quick response in required (e.g. emergencies such as natural disasters).

Once built, the building structure can later be modified, expanded or reconfigured to suit changing requirements relatively simply. In addition, the building structure can be relocated in whole or in part with ease.

Since the component modules are of standard design, the building structure lends itself well to simple computer modelling and virtual reality systems that enable layout planning. The simplicity would also enable the end user of the building to participate in the design of the building.

The modular nature of the building enables it to be enlarged or reduced in size as appropriate. This may have advantage for both the residential and commercial market. For example, first time residential buyers will be able to start with a small one bedroom house, expand the size of the building over time by adding extra modules as the family grows and reduce the size of the building by removing modules as the family size diminishes. The style of the house can be constructed to suit the owner's preferences. Similarly, in the commercial realm the size of the building can be varied throughout its life to reflect the growth or diminishing size of the business.

Similarly, disused modular buildings can be dismantled and removed so that ugly, dilapidated or vandalised buildings can be quickly removed. A minimum disturbance to land structure means that land can be returned to green site conditions after the buildings have been removed

Valuing property for sale or financing purposes is simplified in that the value of the property is no longer restricted by its location and design and can be easily assessed by the aggregate value of its component parts while the site is valued separately in terms of size and location.

The present invention provides for improved durability in prefabricated buildings of about 40 years with a higher standard of interiors and internal services as compared to the 15 years for existing structures.

CLAIMS

1. A modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service.

2. A modular building structure according to claim 1, wherein each module is an open-ended box configuration.

3. A modular building structure according to claim 1 or 2, wherein the service module is in the form of a corridor walkway linking the building modules.

4. A modular building structure according to claims 1, 2, or 3 wherein the service module has floor and ceiling cavities in which the mains service supplies are routed.

5. A modular building structure according to any one of claims 1 to 4, wherein one building module is a dedicated plant room that feeds the mains supply service to the service module.

6. A modular building structure according to any preceding claim, wherein the service module is sectional so that it can be extended or shortened to provide more or less connection nodes as required.

7. A modular building structure according to any preceding claim wherein there is provided a plurality of service modules, some modules being disposed in a direction transverse to others.

8. A modular building structure according to any preceding claim, wherein the mains service is for waste disposal and each service module is provided with a holding tank that is connected to a lavatory or wash area of an adjacent building module.

9. A modular building structure according to claim 8, wherein holding tanks of adjacent sections of a service module are connected by a suction waste pipe.

10. A modular building structure according to any preceding claim, wherein the mains service supply is air conditioning and each service module is fitted with a heat exchanger and has an external pump for evacuation of warm air.

11. A modular building structure according to claim 10, wherein each building module also has its own heat exchanger that is connected to the pump and heat exchanger of an adjacent service module.

11. A modular building structure according to any preceding claim, wherein each adjoining pair of building modules or service modules has apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is snugly received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

12. A modular building structure according to any preceding claim, comprising multiple storeys, vertically adjacent modules being connected by a connecting member comprising a resilient flexible insert attached to one module and received in an aperture of the vertically adjacent module.

13. A modular building structure according to any proceeding claim, wherein the modules are connected to a foundation of foamed mineral in-fill.

14. A method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting it to the mains supply service of the service module.

15. A method according to claim 14, comprising further steps of filling a clearance between the module and ground with a foundation of foamed mineral in-fill.

16. Apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being that is received in the aperture and supported on a fixing element that is secured to said adjacent building module.

17. Apparatus according to claim 16, wherein each horizontally adjacent module has an aperture, the flexible resilient insert is received in each aperture and bridges the two building modules.

18. Apparatus according to claim 16, wherein the modules are vertically adjacent, one of the modules having projecting therefrom said resilient flexible insert and the other having said aperture.

19. Apparatus according to claims 17 or 18, wherein the housing further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

20. Apparatus according to claim any one of claims 16 to 19, wherein the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

21. Apparatus according to any one of claims 16 to 20, wherein the insert is a grommet.

22. A modular building structure substantially as hereinbefore described with reference to the accompanying drawings.

23. A method for constructing a modular building structure substantially as hereinbefore described with reference to the accompanying drawings.

24. Apparatus for connecting adjacent building modules substantially as hereinbefore described with reference to the accompanying drawings.

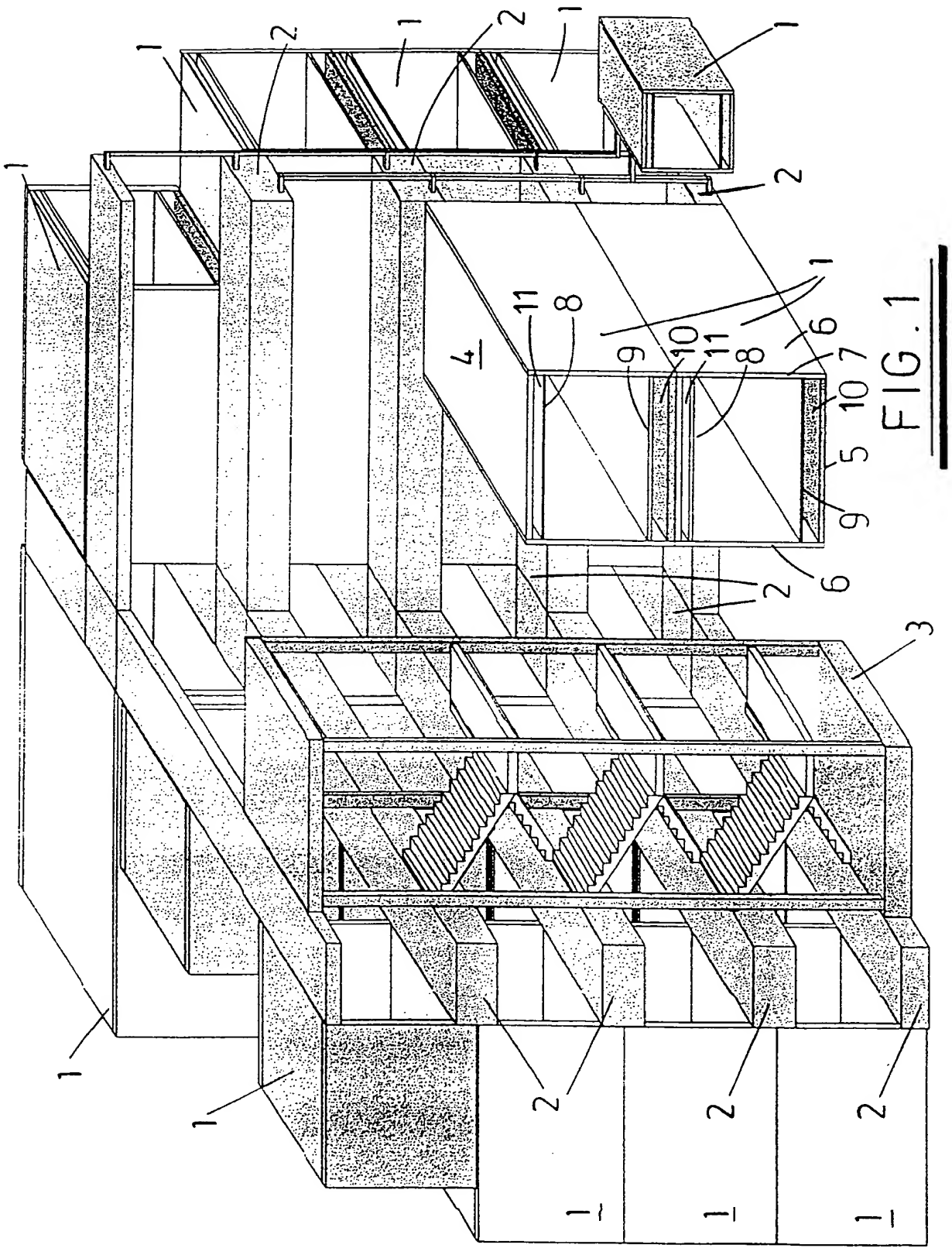


FIG. 1

FIG. 3

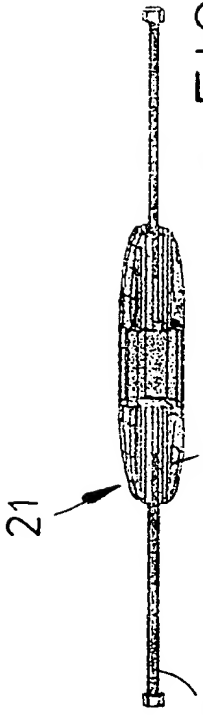


FIG. 4

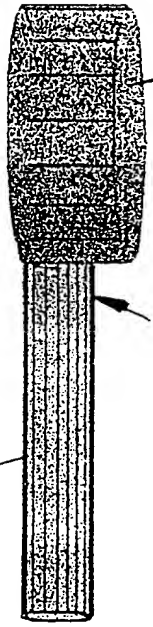
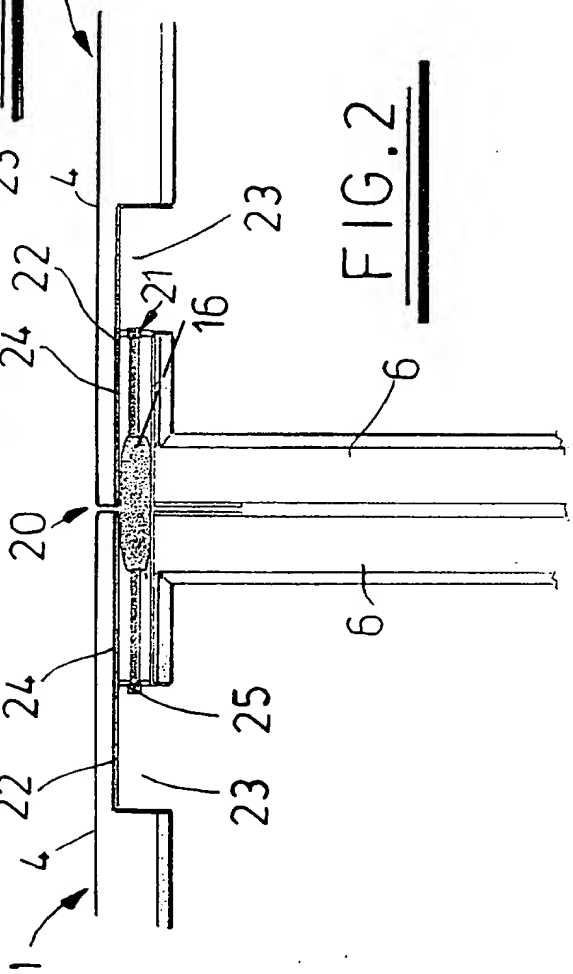


FIG. 2



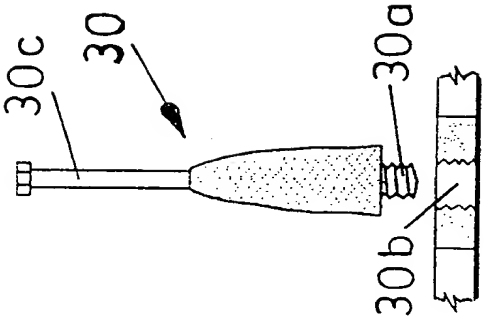


FIG. 4a

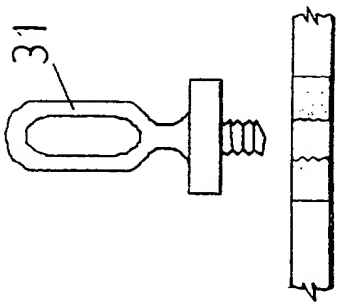


FIG. 4b

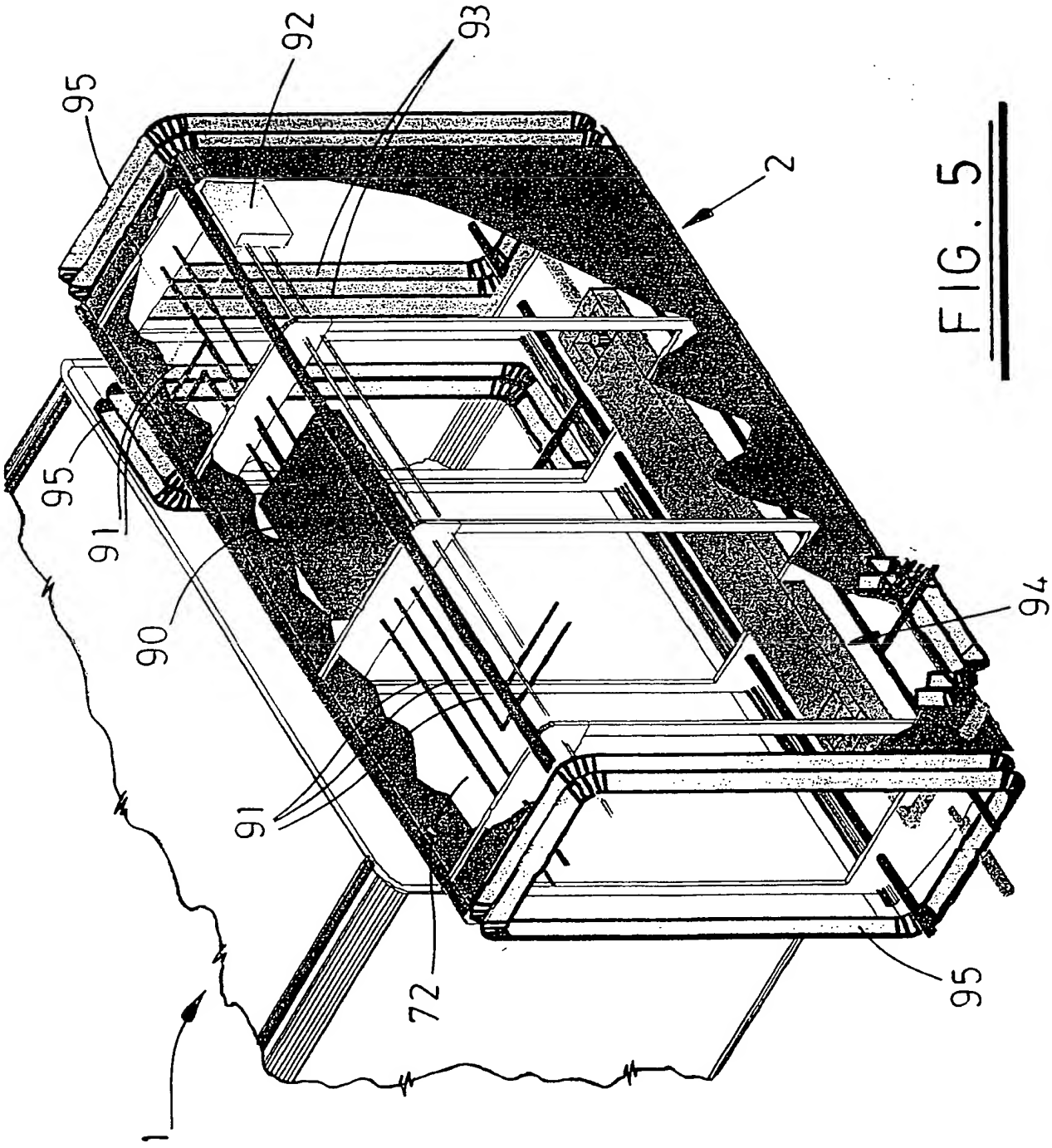


FIG. 5

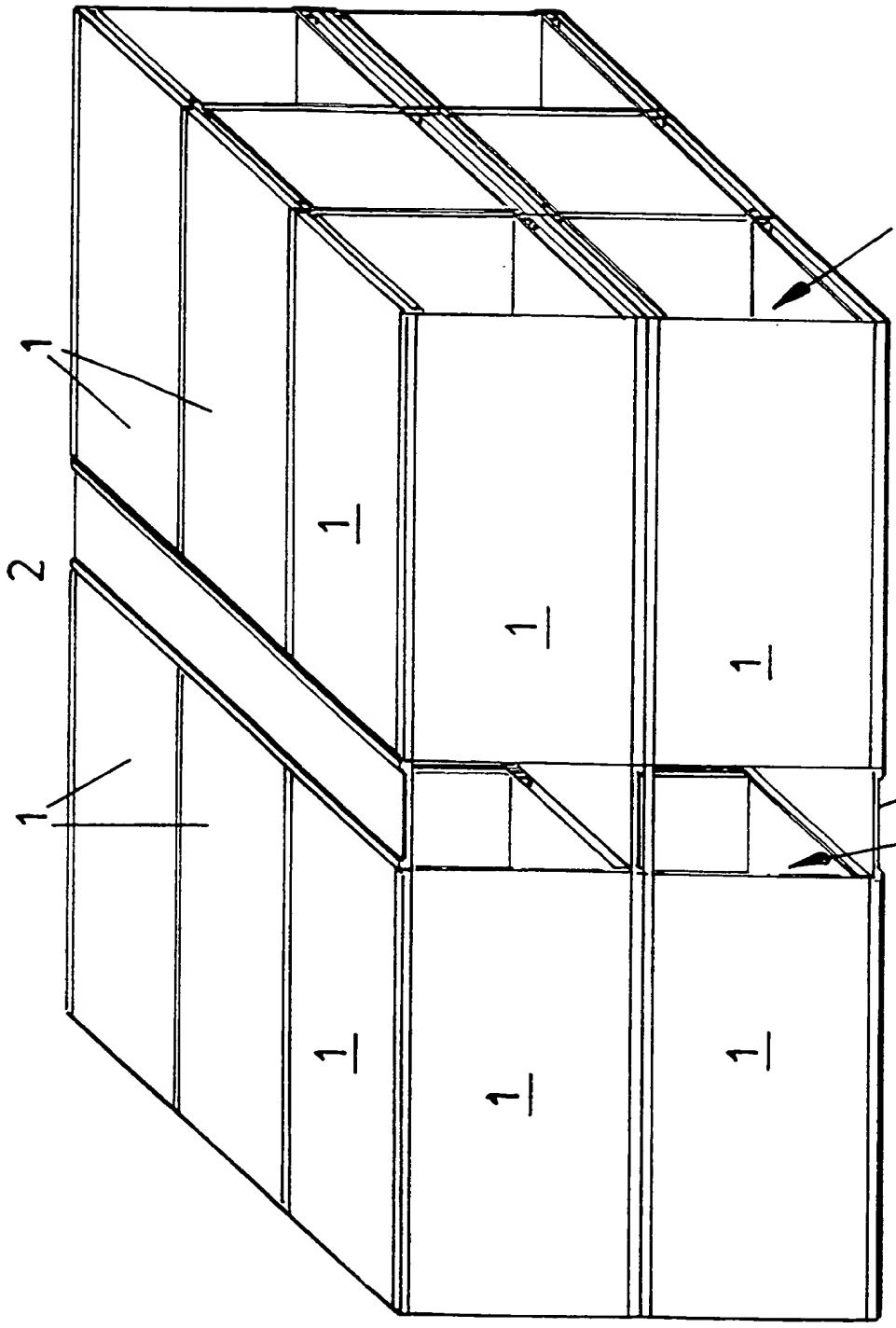


FIG.6

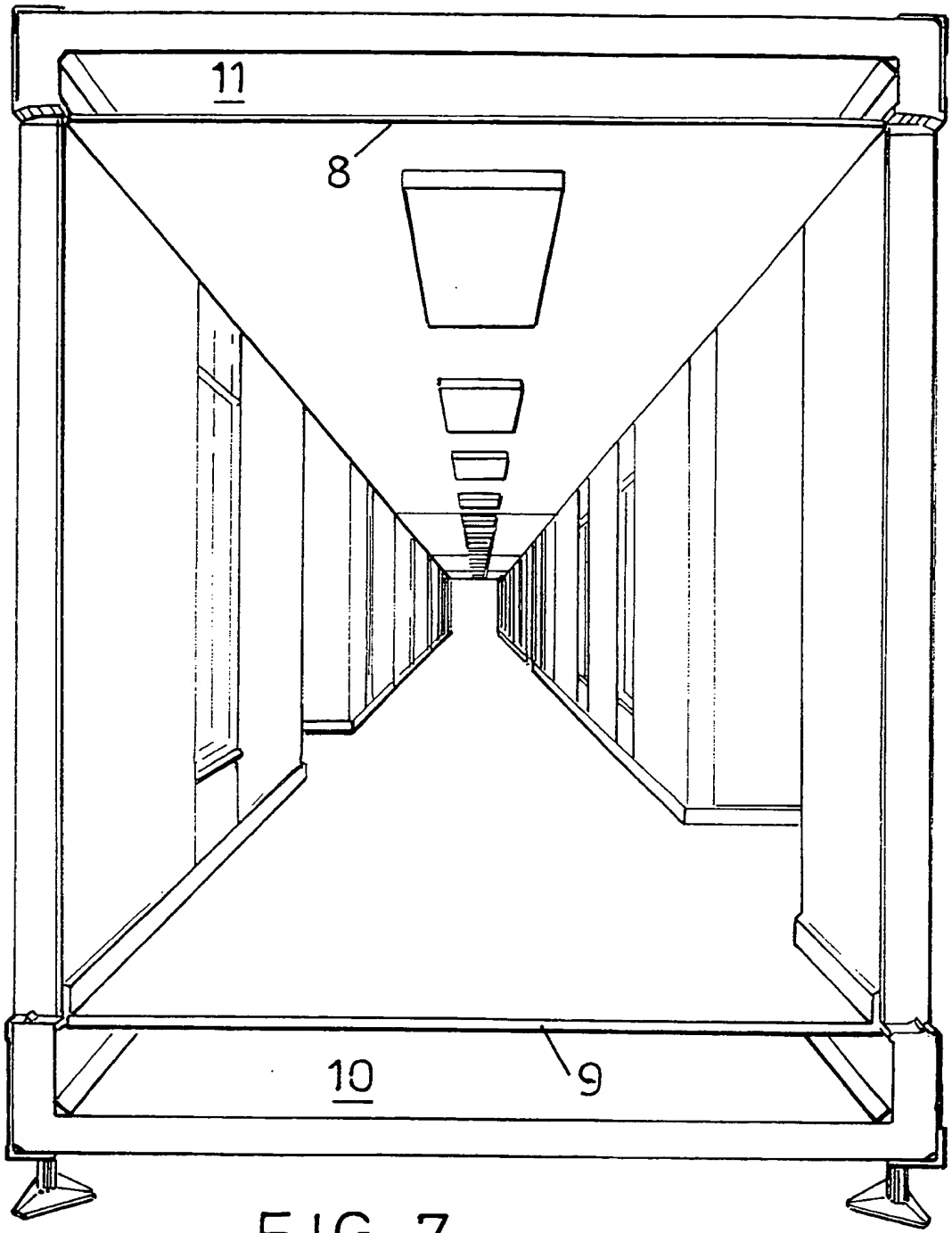


FIG. 7

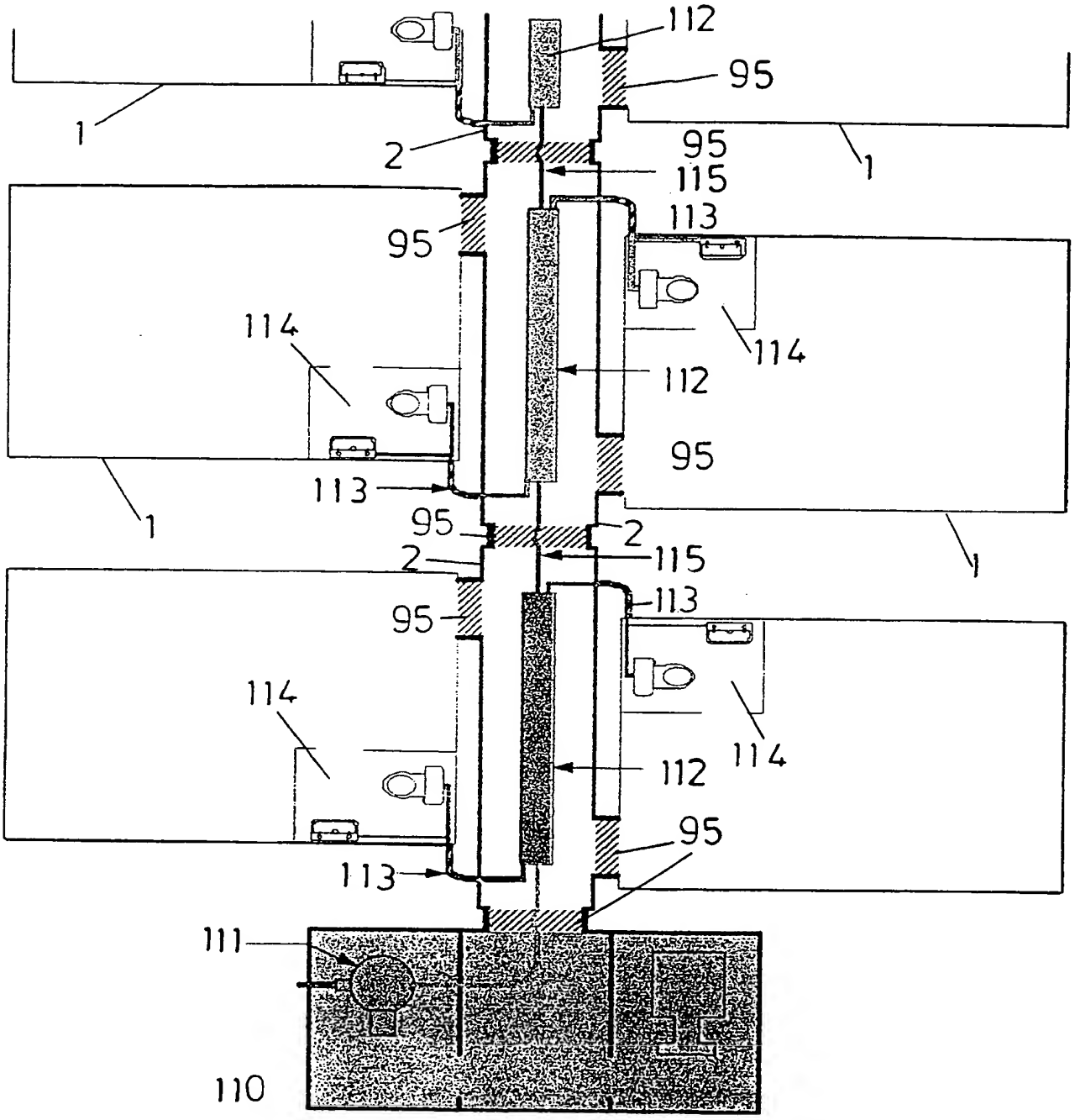

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FIG. 8

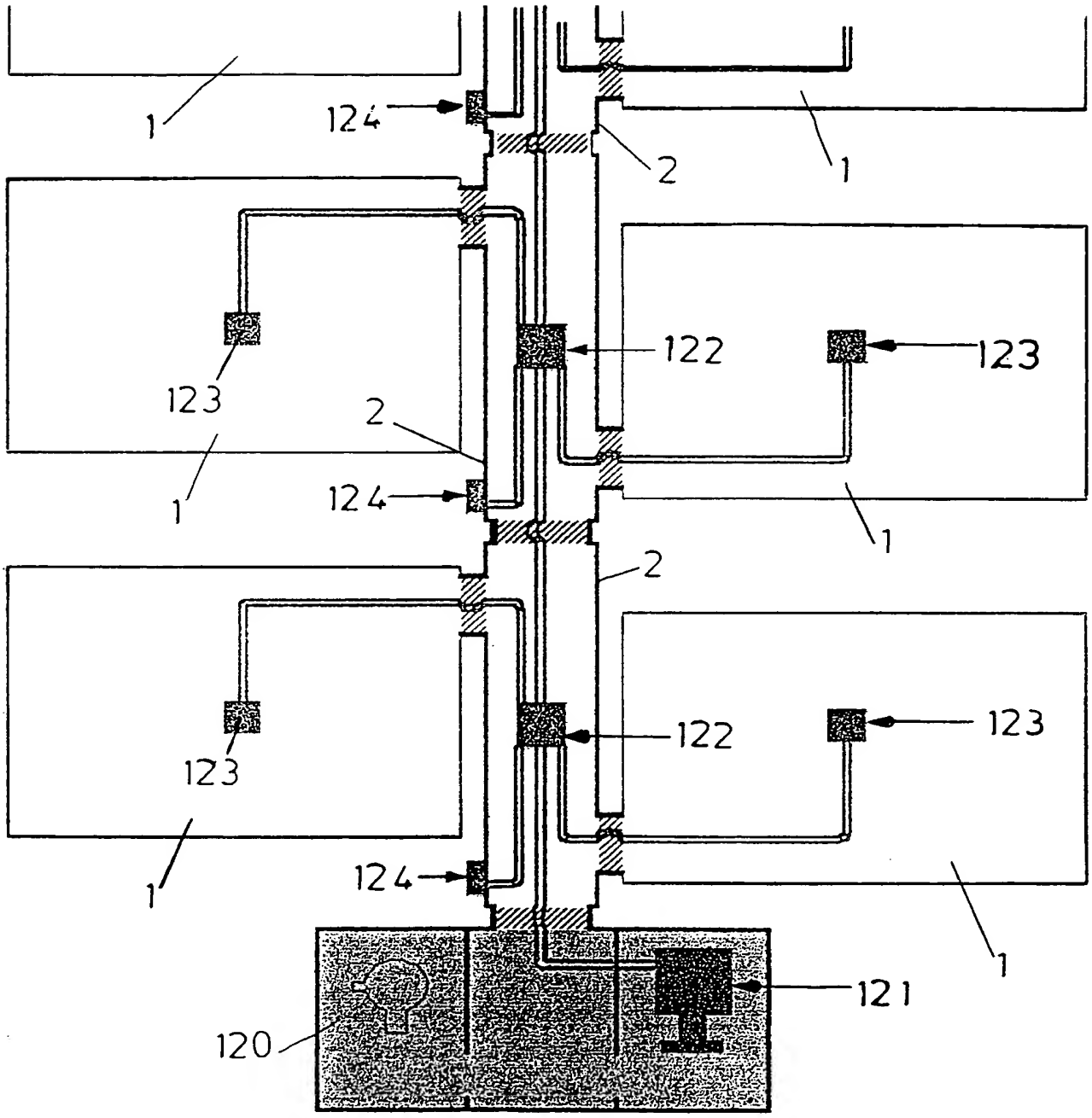
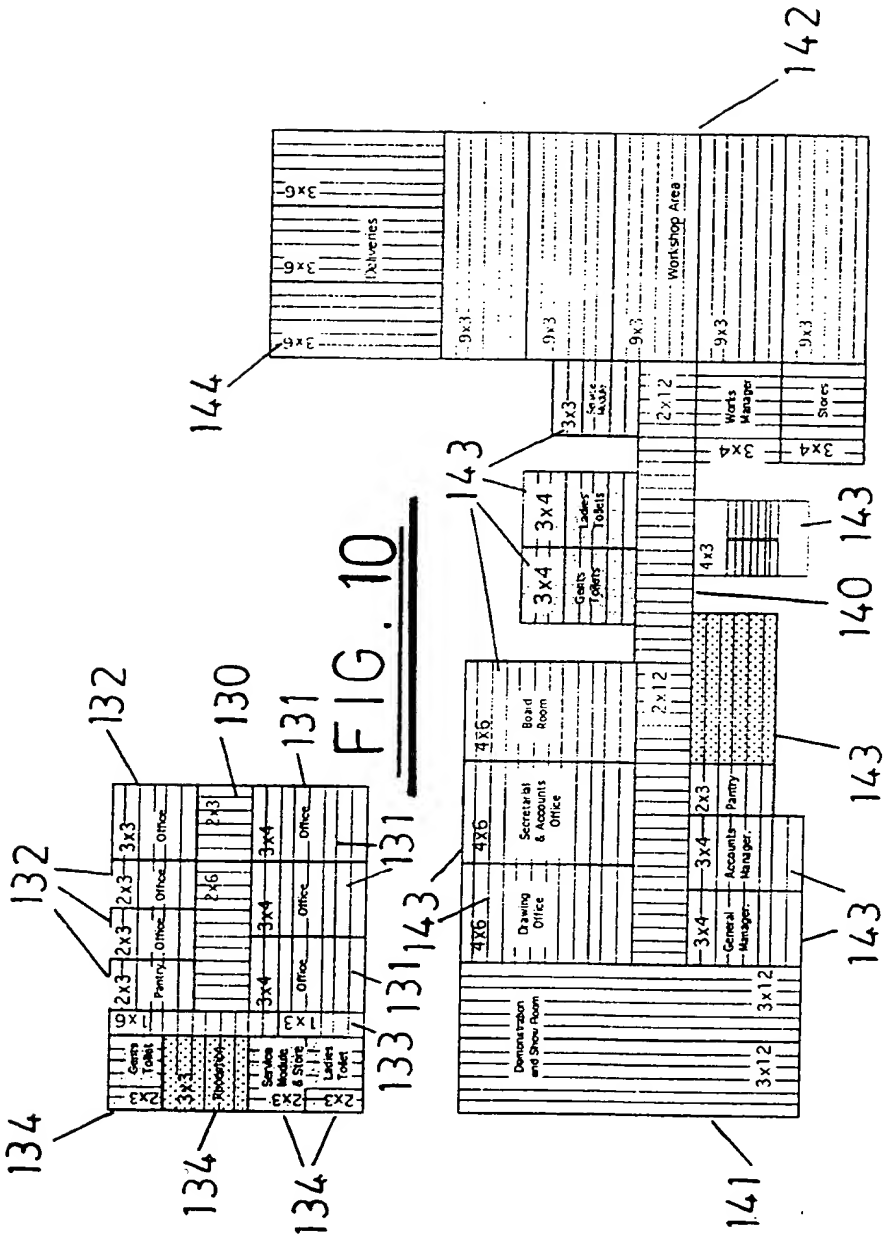


FIG. 9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Store
Ladies Toilet
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144
143
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Deliveries
Workshop Area
Works Manager
Stores
Stores Assist.
Ladies Toilets
Gents Toilets
Board Room
Secretarial & Accounts Office
Drawing Office
Demonstration and Show Room
Accounts Manager
General Manager

FIG. 10

FIG. 11

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/GB 99/02141

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B1/348

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 32 26 742 A (DIETRICH RICHARD DIPL ING) 19 January 1984 (1984-01-19)	1,2,5,23
A	page 9, line 16 -page 13, line 23; figures 1,2	7,10,13, 15,24
X	US 3 742 666 A (ANTONIOU A) 3 July 1973 (1973-07-03) the whole document	1,15
A	GB 1 493 802 A (PORTAKABIN LTD) 30 November 1977 (1977-11-30) the whole document	1,12,17, 21,25
A	DE 32 29 881 A (INTERATOM) 16 February 1984 (1984-02-16) the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1999	22/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Vrugt, S

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

ormation on patent family members

Intern nal Application No
PCT/GB 99/02141

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